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The second Paper read was—

2. *Communication with America, viâ the Faröes, Iceland, and Greenland.*

By COLONEL T. P. SHAFFNER, U.S.

THE North Atlantic Telegraph, which has been struggling against formidable rivalry for some years past, is now rapidly assuming a form and proportion commensurate with the grandeur of the enterprise. The route preliminarily proposed for this project is as follows, viz., *first* from the North of Scotland to the Bay of Thorshaven, Stromöe Isle, of the Faröe Isles. The length of the cable for this section will be about 250 miles. The next section will run from Westermanshaven, of the same Isle, to about Portland, South Iceland, a distance of about 350 miles. From this landing the line will be constructed across Iceland to Reikiavik. From the Bay of Reikiavik the next section of cable will be run to some bay on the east coast of Greenland, south of latitude 61° north. This distance will be about 550 or 600 miles. It is proposed to run the line across the southern end of Greenland. The fourth section of cable will be run from one of the bays of the west coast, south of the latitude 61° north, to Hamilton's Inlet, on the Labrador coast, a distance of about 600 miles. The aggregate submarine telegraph will be about 1750 miles; land lines about 300 miles; total, some 2050; about the same length as the Atlantic cable from Ireland to Newfoundland.

The Danish Concession.—The concession for this telegraph has been granted by His Majesty the King of Denmark so far as it may occupy Danish territory. There is no monopoly of the line reserved to the Danish Government, but its impartial use is guaranteed to the whole world. The Government has pledged itself to "bestow all necessary care, vigilance, and means which may be within its command to insure the free, impartial, and unhindered use of the said telegraph line." If, however, the British Government should desire a wire for the transmission of its own despatches, a franchise can be given to it, and the use of that franchise will be defended by the Danish Government "with all the means within its command."

Telegraphic Manipulation.—There is no submarine telegraph line with an electrical circuit of 1,000 miles, nor have we any practical evidence that a circuit of that length can be worked for commercial purposes. It might be possible to organise a cable to work with some facility on a submarine circuit of that length, but to what extent would be its commerciality remains an unsolved problem. The longest subaqueous circuit now operated is about 750 miles, and the speed of transmission thereon is some seven words per minute.

On an air line of that length the transmission would be instantaneous, and on such lines the art of telegraphy is but a question of mechanism. On a telegraph line constructed through the air, perfectly insulated, and traversing an even and favourable temperature, a thousand words can be transmitted in one minute by the aid of mechanism. The ordinary manipulation, however, is with the hand, by the opening and closing of a given metallic circuit charged with electricity. The maximum transmission in this manner may be considered at about forty words per minute. The speed of transmission of the electric force through submarine cables depends upon the conductivity of the metal, its insulation, and length of circuit. I have good authority for saying that experiments, instituted in England with No. 16 copper wire, have proved that the electric current requires one-third of a second for the first 500 miles, and one second for 1000 miles. According to this progression, the time required to transmit an electrical impulse 2000 miles would be about nine seconds. This delay or hindrance is called "retardation." The cable becomes a Leyden jar, and the current transmitted is, more or less, held in suspension until discharged by some contrivance. It is owing to this suspension or retardation, and the irregularity of its time, that long submarine telegraphs cannot be made effective for commercial purposes.

Circuits of the Northern Route.—The electric circuits of the North Atlantic telegraph will be short—the longest about 600 miles, and cables can be laid capable of transmitting at least twenty words per minute. It will be a financial question that will determine the capacity of the cables for the commercial telegraphy. Between Scotland and the Faröes, and between the Faröes and Iceland, cables can be laid that can equal the working of a double line of cables across the other sections of the route, or perhaps it may be found best to construct them for the short sections with two wires for telegraphing, and on the other sections with three or more conducting wires. If either one of the sections fail, the whole are not lost, and another cable can be promptly submerged.

The Seas.—The depths of the seas are but little known. A few soundings were taken on the route last autumn. The water between Scotland and the Faröe Islands, and thence to Iceland, is not very deep, not exceeding, perhaps, 1000 fathoms, and there can be no doubt but that the bottom is very deep mud. The soundings taken last fall between Iceland and Greenland proved the bottom in that sea to be deep mud. The greatest depth of water was 1540 fathoms. The mud brought from the bottom has been examined by Professor Ehrenberg, of Berlin, and he says that he found

it "to contain numerous shells with life-being forms therein, which, in his opinion, exist alive at the bottom of the sea." With regard to the sand contained in the specimens, he says that "it is no rolling sand, but fragmentary, broken, and dissolved stones of mountains. The granules are not round, but with acute sides. The granite sand consists of much glimmer and quartz, with green crystal fragments, which might be hornblende were there particles of pumice-stone, but which are not at all therein to be found." From the evidence which we have in the premises, it would seem that the bottom of the sea gradually descends to 1540 fathoms from Iceland, and then in the same manner ascends to the Greenland coast. To determine the correctness of this opinion, farther soundings are required. The Arctic current, perhaps some thirty feet deep, and by some supposed to be fifty miles wide, carries with it large quantities of ice, from which earth drops to the bottom of the sea. The sea between Greenland and Labrador was also partially sounded by me last fall, and the greatest depth was found to be 2090 fathoms, which was about under the Arctic current, west of Greenland, latitude $61^{\circ} 05'$. North-west of this sounding the deepest water found was 1840 fathoms. The bottom in Davis Strait was soft mud, except under the Arctic current, where it was coarse sand, which had been evidently dropped from the ice. On many icebergs may be seen large quantities of sand and boulders of several inches in diameter.

Landings for the Cables.—The precise places for the landings of the cables have not yet been determined upon. There are good bays on North Scotland, and there need not be any fears as to that part of the route. The bay of Thorshaven, island of Stromöe, of the Faröe group, is approached from the deep sea without obstruction, and its bottom is sand. The average depth of water in the bay is about 20 fathoms. Thorshaven is the capital of the Faröe Islands, and has about 900 inhabitants. The cable to Iceland will leave Westermanshaven on the west coast of the Stromöe Isle. The bay is deep, bottom sand, and free from the ocean waves. On the south coast of Iceland, about long. 19° w., or at Portland, it is proposed to land the cable. The bottom of the sea approaching nearly the whole south coast of Iceland is sand. The coast is free from ice winter and summer. The cable to Greenland will run from the Reijkia-*vik* bay. The depth of water in this bay is favourable, the bottom is mud and sand. It is free from ice winter and summer, excepting a little crust near the shore. Arctic ice is never seen in that bay, except, perhaps, once in a century. Reijkia-*vik* is the capital of Iceland, and its inhabitants have the highest degree of education.

The landing places on Greenland require to be selected with great care, and after much investigation. It is proposed to land on the east coast, in one of the many bays south of latitude 61° north, and on the west coast near the town of Julianshaab, or south of that place, connecting the two with a line across Greenland. The bays penetrate to the interior ten, twenty, or thirty miles, and some of them never freeze, nor does the ice from the sea go up them but a few miles. They are very deep, and bergs never ground in them; the bottoms are of mud and sand. The characters of the bays on the two coasts are much the same, and the Arctic current does not approach the coast on either side. From the sea into these bays the water is deep far below the reach of the greatest icebergs. To make the selection of the proper bays for the landings of the cables the fullest information as to the depth of water from the sea will be required. Some of the inlets bring out ice, but the most of them do not; many of them are ten miles wide. As to Labrador, Hamilton's Inlet affords all the desired advantages. This inlet runs interior about 140 miles, and at its mouth it is thirty miles wide. The water is deep, and the bottom is sand. At its mouth there is a deep trench to sea, and a cable laid in that trench would never be disturbed by the sea. Above and below the mouth of Hamilton's Inlet there are shoals or reefs, some thirty miles from the coast, and many icebergs ground on them. After they melt or break to pieces they pass over and beyond the mouth of the inlet. They never ground at the mouth, nor do they enter into the inlet.

Icebergs.—The landings on the Farøe Islands and Iceland will never be disturbed by ice. They are open ports, and vessels can go and come from them at all seasons of the year. The coasts of Greenland and Labrador are beset with much ice. The east coast of Greenland is but little settled. The inhabitants trade with the colony near Cape Farewell, and they go and return from time to time in their skin boats. The Arctic or Spitzbergen current, with the floe ice, does not approach the coast, and much of the time that the floe ice runs between Greenland and Iceland the water near the coast is free from ice. The floe ice on the east coast may be seen in more or less quantities in the months of February, March, April, May, and a part of June. Sometimes it appears in the last days of January, and occasionally disappears in May. The coast or berg ice may be seen occasionally throughout the year. On the east coast neither the berg nor the floe ice penetrates the bays, and a cable laid therein would never be disturbed by them even were the waters shallow. The hills on the coast are covered with grass and berry bushes. The climate is not severe. The native ice is not

very thick ; and if it were, the cable could not be injured by it. The west coast in Julianshaab district is settled by some 3000 Esquimaux and Danes. Their houses are to be found on many of the hills, and the skin boats are to be seen at nearly all times in some of the bays. The floe ice runs northward a few miles from the coast during the months that it is seen on the east coast. Between the green hills and the floe the sea is open and free from ice, except, perhaps, here and there a berg may be seen. Icebergs from Baffin Bay, or the various "blinks" more northward, will be found scattered along the coast. Some ground on the reefs or shoals, some are blown into the bays, and others pass off to the south. Those blown into many of the bays seldom, if ever, get out. If the bays have currents from the interior, they are taken out to sea ; but if their waters be quiet, as many of them are, the bergs are blown to the land and ground. There they remain until the winds, the sun, and the tidal waves crumble them to pieces. Between the Arctic current and the coast many of the icebergs remain for weeks, and, in fact, until broken to pieces and melted. The largest iceberg may be some eighty feet above water ; but as to their depth in the water, no one knows, nor is it possible to ascertain. The theory as to the specific gravity of ice cannot be applied to determine the depth of any given berg. The ice above water may be the cone ascending from a very broad base. In most cases very high bergs are very wide below water, and when the base becomes reduced the berg falls, and a new projection is seen from the water. The crumbling of bergs, and the changing of their positions, are to be seen going on at nearly all times. A rough sea soon exposes the form and size of the berg, and a careful judgment can determine the probable bulk. The bergs on the Labrador coast are of the same kind as those on the Greenland coast. They go south in great quantities until checked by the eddy currents on the east coast of Newfoundland. Many of them enter the bays of Newfoundland, and a cable laid therein will be more liable to be injured by the ice than those laid on the Greenland or Labrador coasts.

The North Atlantic Telegraph is an enterprise practically complete in all its parts, so far as pertains to demonstrated philosophy. In its construction and subsequent operation there will be nothing to discover, nothing to invent ; but we have only to follow the sciences and arts as effective, at this time, in commercial telegraphy, and our efforts will be crowned with a success that will add new glory to the age in which we live.

The PRESIDENT said the first paper propounded a very ingenious theory, upon which, as it involved many complicated scientific questions, he would not

undertake to pronounce any positive opinion; but he trusted there might be some gentlemen present who, from their acquaintance with the Arctic regions, would be competent to speak upon the questions submitted to them. They were especially obliged to Mr. Alderman Hopkins for coming from Manchester to give to them the results of his researches and inquiries. With regard to the other paper, it was also a subject of congratulation when gentlemen from foreign countries were kind enough to come and submit their investigations to the Society. Every scheme which tended to unite this country with America, and to facilitate intercourse between them, would always be hailed with the greatest satisfaction. But in the case of the present proposals the first thing required was that the whole line proposed to be traversed by the electric wires should be carefully examined and surveyed, and that the route which ultimately proved to be the best should be adopted. Such an investigation would have a peculiar interest for geographers, relating as it did to the physical formation of a hitherto unexplored portion of the earth.

MR. LIONEL GISBORNE, F.R.G.S., thought the two papers were contradictory to one another. Mr. Hopkins tried to prove that in the polar region there was a warm latitude which might be reached by shipping. Colonel Shaffner tried to prove that between Scotland, Faröe Islands, Iceland, and Greenland, there was also a warm latitude, or such a latitude that a telegraphic cable might be laid without being troubled by icebergs. He should confine himself to the geographical portion of the question. Colonel Shaffner had omitted one most important element in the consideration of the question, and that was the effect of terrestrial magnetism upon the telegraph. We knew from the experience of submarine lines that the difficulty of making an instrument delicate enough to record a signal at a long distance was chiefly caused by the amount of terrestrial magnetism to be overcome, the magnetism sometimes being induced by the telegraph itself. If terrestrial magnetism in the polar regions was far greater than in the latitude of the old Atlantic line, he thought it would be found a most important objection; therefore, should any survey be made, that was a point which ought to be urged upon investigators. Apart from this probable difficulty, there were other questions to be investigated connected with the working of the line, principally the question of icebergs. He had the opinion that icebergs were prevalent about Iceland, Greenland, and Labrador; and if Colonel Shaffner could show that there were inlets and bays on the coast in which a cable could be landed safe from the effects of icebergs, he would have established a fact not generally known, and a most important fact in the physical geography of that country. Supposing these two points satisfactorily settled, then came the question of advantage: What advantage was there in the proposed route, when the two termini of the line would be such a long distance from the points wanted to be reached—London and New York? Taking a broad view of the question, he should not be disposed to go to a part of the world with such a delicate thing as electricity, where every book on the subject showed there were currents, great differences of temperature, icebergs, and changes in the formation of the country, to be encountered. The only advantage offered by Colonel Shaffner was that of having a fresh battery every 500 or 600 miles; that was an immense advantage; and if it could be proved that the difficulties to which he had referred did not exist, then, undoubtedly, the route proposed would have advantages not possessed by any other in that respect. Whatever opinion he might hold as to the feasibility of the plan, must be controlled by new facts, which a proper survey could alone establish.

MR. J. STUART WORTLEY, F.R.G.S., said the question of the proposed telegraph had several characters: its physical character, which more immediately came under the attention of a Society like that, its political character, its commercial character, and its electric character. The last three did not come within the province of the Society. With politics they had nothing to do; yet he would remind the meeting that Colonel Shaffner did not afford a British line,

nor even a British-American line. It would traverse Danish territory : at any time when European politics disturbed the relations of this country, the line itself might be disturbed. With regard to the commercial part of the question, Colonel Shaffner had omitted to state the expense of maintaining the numerous stations at the Farøe Islands, in Iceland and in Greenland. Upon the electrical part of the question he did not presume to touch : he was not an electrician, and that subject was far too difficult for him to deal with. It had been alluded to by Mr. Gisborne, and all that he would say was this, that it had been proved by experiments that it was possible to communicate by electricity 1900 miles. He held in his hand an American newspaper, containing five and a half columns of actual messages which were sent from this country to America by the Atlantic telegraph.

But with regard to the geographical question, Colonel Shaffner would be the first to admit that his examination of these seas was exceedingly cursory and imperfect, and unsatisfactory. It was most important that our Government should survey this line, as well as every other line suggested to cross the Atlantic. It was a national object to get the best line, and it was the duty of Government to assist commercial enterprise by first ascertaining that point. He thought Colonel Shaffner rather underrated the distance between Iceland and the point of Greenland which he mentioned : it was nearer 700 miles than 500. Nearly all authorities agreed in discouraging that particular line. It was new to hear that the east coast of Greenland was free from ice. In Norie's chart the whole of that coast was designated as an impenetrable field of ice ; and he held in his hand the log of the vessel in which Colonel Shaffner sailed, and it was there stated that they were beset with ice at one time and lost all control of their vessel, and that at other places they saw thousands of icebergs. Enough had been learned to show that at all seasons of the year there would be considerable danger not only in navigating those seas, but also in laying a cable worth two or three hundred thousand pounds. Beyond that there were the Spitzbergen currents bearing down the east coast of Greenland, bringing with them ice, drift timber, and all sorts of wreck, which in itself would be a discouraging circumstance to anybody laying a cable in those seas.

DR. HODGKIN, F.R.G.S., thought that after the failure of the Atlantic cable, which had caused such general regret, we were much indebted to Colonel Shaffner for proposing a means of overcoming the difficulty. The objections which had now been urged were based upon supposition only, and ought not to turn aside inquiry. When in Pisa last year he had had the opportunity of conversing with that distinguished electrician Professor Matteucci, who, as director of the Tuscan Government's telegraphic establishment, had great experience. It was the Professor's opinion that there were electric difficulties in the way of transmission to so great a distance as across the Atlantic, with which we were not at present fully acquainted. These difficulties would be diminished by the Colonel's plan of breaking the distance, which had the additional advantage of reducing the amount of loss in case of the breaking of the cable. The risk from icebergs would only exist during the operation of laying down the cable, for when once laid down in deep water it would be below the reach of the largest icebergs. In shallow water near the shore it might be injured by them ; but from the description given of these coasts it was pretty certain that favourable places might be selected where, from the depth of the sea close to the shore, even this risk would be small. He further observed that the proposed line of cable kept clear of the eastern shore of Greenland, which, like other eastern shores in those regions, had been shown to be the most blocked by ice.

SIR EDWARD BELCHER, F.R.G.S., said it would be impossible to navigate the Polar Seas in the winter months. Steam was entirely out of the question, and sailing vessels would be entirely at the mercy of drifting ice. With respect to the feasibility of telegraphic communication, he was not disposed to rest upon the *ipse dixit* of any man who had not been on the ground. His rule was to

rely solely on experiment. For instance, it had been asserted by the most eminent navigators that at Point Venus, Tahiti, it was invariably high water at noon. Close observations for six weeks proved this to be utterly untrue, for the tide ranged from 9:30 A.M. to 2:30 P.M.; and in the present case he entirely disagreed with the impression that ice was so prevalent on the eastern coast of Greenland. The Arctic expedition, which left the Orkneys in the month of May, 1852, never met with an iceberg until it nearly sighted Cape Farewell; and Captain Allen Young, when in a Greenland port, seeing the ice moving at what was considered to be a rapid rate, measured the rate of progression with a theodolite, and found it was about one mile in twenty-four hours. Another traveller (Scoresby, I think), who went all along that coast, stated in conversation at the meeting of the British Association at Swansea that, "when one of these bergs calved or split off from the land, it went down absolutely under water, then rose and floated off:" consequently there was good reason to calculate on deep water there, and a cable could be run up to the side of a precipice at a depth where it would be safe from icebergs, and then carried over or along the base of the precipice. On the banks of Newfoundland he measured a pinnacle iceberg, and it was found to be 150 feet high; in a short time it turned over, and was then not more than 80 feet above water. Icebergs were very different from floe ice. Floe ice seldom exceeded three or four feet in thickness in the floes they docked in during their progress in Davis Strait: it was salt-water ice, and was about eleven-twelfths immersed. The iceberg is a fresh-water formation, and derives its formation from the thawing snow trickling over the side of a mountain. This gradually freezes until the accumulated mass becomes too heavy to be retained by cohesion; it then, as it is termed, "calves" or breaks off and falls into the sea. It was generally supposed to be nine-tenths immersed, by authorities who vary considerably. It has been stated that somewhere about the mouth of Davis Strait, on the Labrador shore, a barrier existed, upon which icebergs ground, and thus deflect the drift of the pack off the land of Labrador, and after passing about 200 miles westerly of the straits of Belleisle, they again turn in about St. John, Newfoundland, which harbour they frequently blocked. Government, he thought, ought to examine into this question relative to deep sea soundings or banks adapted for fishing, &c. We want the facts as to the true nature of the bottom determined before any attempt was made to lay a cable.

COLONEL SHAFFNER said he had the evidence of the Government of Iceland that ice did not exist there. The question of terrestrial magnetism was deserving of investigation. With regard to the alleged log which Mr. Stuart Wortley had mentioned, he had in his own possession the entire log made by the first mate, and it certainly contained no information as to the vessel having been beset with ice.

MR. ALDERMAN HOPKINS said it seemed to be assumed by one gentleman that he proposed to attempt the passage to the North Pole in the winter. He certainly had no such intention, and he did not think his language bore that construction. He alluded to the state of things in the winter merely to show that there were some extraordinary causes in operation at that season of the year; but he then went on to show that in the summer circumstances were of such a character as to afford a reasonable expectation that with proper means the attempt to reach the Pole might be made with success.

The PRESIDENT congratulated the meeting upon the interesting character of the discussion, and expressed a confident hope that much geographical knowledge and advantage would be derived from a farther investigation of both the questions which had been brought forward. As Mr. Wortley had ventured to touch upon politics, perhaps the meeting would permit him to say that they were very much obliged to the Danish Government for encouraging an enterprise of this description, and that, if it were carried out, it would tend to cement the friendly intercourse and union which existed between the two countries.